

REMARKS

By the above amendment, independent claims 1 and 4 have been amended to more clearly set forth the features of the present invention with dependent claims 2, 3 and 5 - 7 being canceled and new dependent claims 8 - 11 presented.

At the outset, applicants note that the present invention relates to a semiconductor production apparatus which detects, by using an interference light of at least two wavelengths corresponding to a predetermined etched amount, such as a remaining film thickness, a particular change such that the amount of the light of one of the two wavelengths assumes a maximum value and the light amount of the light of the other wavelength becomes minimum, whereby the particular change of the etching amount is detected by using the interference light of plural pairs of wavelengths, respectively, corresponding to etched amounts in accordance with the etching process. In this manner, the detection accuracy of the etching amounts is improved, as described at page 22, line 25 to page 23, line 15 of the specification in conjunction with Figs. 3 and 4, for example. Applicants submit that the recited features of the claims, as amended, are not disclosed or taught in the cited art, as will become clear from the following discussion.

The rejection of claims 1 - 5 on the ground of non-statutory double patenting over claims 1 - 5 of US Patent No. 6,972,848; the rejection of claim 1 - 7 under 35 USC 102(e) as being anticipated by Usui et al (US Patent Publication No. 2004/0174530); the rejection of claims 1 - 7 under 35 USC 102(b) as being anticipated by Helmann et al (EP 0412728A2); and the rejection of claims 6 and 7 under 35 USC 102(b) as being anticipated by Coronel et al (US 5,658,418); such rejections are traversed insofar as they are applicable to the present claims and reconsideration and withdrawal of the rejections are respectfully requested.

With respect to the rejection on the ground of nonstatutory double patenting over claims 1 - 5 of US Patent No. 6,972,848 and the rejection of claims 1 - 7 under 35 USC 102(e) as being anticipated by Usui et al (US Pub. 2004/0174530), applicants note that the patent publication of Usui et al issued as US Patent No. 6,972,848 and are based on US Patent Application No. 10/377,823, filed March 4, 2003, which is referred to in the specification of this application, and the disclosure of which is incorporated by reference herein. Furthermore, it is noted that several inventors of the present application are also inventors of the referred to application and resulting patent and the present application and the patent have a common assignee.

As recited in amended claims 1 and 4, the semiconductor production apparatus, according to the present invention, includes "a determining device which determines an etching quantity of the wafer, which varies as long as the etching process proceeds, based upon a particular change arising in the interference light of plural pairs of wavelengths, the plural pairs of the wavelengths corresponding to the etching quantities, respectively, and the particular change being detected by using detected results obtained from the detector". That is, in accordance with the present invention, respective film thicknesses are sequentially detected by using the interference light of a pair of different wavelengths according to the change of the etching amount, i.e., the remaining film thickness. Irrespective of the contentions by the Examiner, the aforementioned features of claims 1 and 4 and the dependent claims are not disclosed or taught by US Publication No. 2004/0174530 to Usui et al in the sense of 35 USC 102 or by the claims of US Patent No. 6,972,848 to Usui et al to support a non-statutory double patenting rejection. Accordingly, applicants submit

that the rejections as set forth based upon the Usui et al patent and/or patent publication should be overcome and all claims should be allowable thereover.

Applicants submit that the aforementioned features of claims 1 and 4 enable the detection accuracy of the etching amounts to improve so that a semiconductor device with fine features can be fabricated. In a semiconductor production apparatus, as in the present invention, in which a film formed on a semiconductor wafer is etched, it is required to form the remaining thickness or the processed amount with a high accuracy so as to cope with the demands for the high-integration of semiconductor devices. To this end, there have been proposed methods and apparatuses which detect the etching amount accurately to adjust the processing condition based on the detected etching amount, as described by the specification, but the prior art techniques have not been successful, as described at pages 3 - 6 of the specification.

Turning to Helmann et al, this publication discloses a technique in which a remaining thickness of a film being processed is detected based on the detection results of the change of the intensity of an interference light of lights reflected from the upper and lower surfaces of the film. In particular, in Helmann et al, an interference light of plural different wavelengths are detected separately, and by utilizing the corresponding relation between the film remaining thickness and the combination of the wavelengths in which the intensities of the interference light of the respective wavelengths become simultaneously maximum or minimum, such a time point is detected where the intensities of the interference light of the respective wavelengths become simultaneously maximum or minimum, thereby to determine that the film reaches a target remaining thickness as a reference thickness. Thereafter, the change of the intensity of at least one of the wavelengths of the

interference light is continuously observed, thereby to stop the etching process when the maximum or minimum light intensity is detected or at a suitable timing between the maximum and minimum light intensities by utilizing the temporal interpolation. However, according to the configuration of Helmann et al, there arises a problem that in the case of detecting the intensity of the interference light of a particular wavelength after detecting that the film reaches the target remaining thickness as the reference thickness, the detection becomes difficult depending on the condition such as a film thickness or a kind of the film. In other words, even if a film remaining thickness at a time point where the intensities of the interference light of the respective wavelengths become simultaneously maximum or minimum is detected as the reference film remaining thickness, when the etching process is further proceeded, there may not arise a case where the intensities of the interference light of the respective wavelengths become simultaneously maximum or minimum, which is the target end point where the etching process is to be terminated. Further, Helmann et al discloses 1,060nm, 740nm and 430nm as the reference film thicknesses. However, in recent years, in order to realize the high integration of semiconductor devices, the initial thickness of the film to be processed is smaller than the reference film thicknesses of Helmann et al. Thus, there arises a problem that, in the process of further etching the film to a target thickness after detecting the reference film thickness, it becomes difficult or impossible to detect a maximum or a minimum value of the intensity of the interference light thereby to detect an end point accurately. In order to obviate such a problem, it is considered appropriate to use interference light of shorter wavelengths so that the intensity of the interference light becomes maximum and minimum until the film thickness becomes the target film thickness from reference film thickness. However, in this case, since light of short

wavelengths is likely to be absorbed in the film to be processed, there arises a problem that the intensity of the light becomes smaller, and so it becomes difficult to detect the film thickness accurately.

In order to solve the aforementioned problems of Helmann et al, the present invention employs the configuration as recited in independent claims 1 and 4 of "a determining device which determines an etching quantity of the wafer, which varies as long as the etching process proceeds, based upon a particular change arising in the interference light of plural pairs of wavelengths, the plural pairs of the wavelengths corresponding to the etching quantities, respectively, and the particular change being detected by using detected results obtained from the detector". According to such a configuration, a time point at which data corresponding to the interference light of plural wavelengths exhibits a particular change is detected with respect to the respective etching quantities which varies in accordance with the advancement of the etching process, thereby to determine the respective etching quantities. That is, the respective film thicknesses are sequentially detected by using the interference light of a pair of different wavelengths according to the change of the etching amount, i.e., the remaining film thickness. Accordingly, the present invention can obviate the problems of Helmann et al and provide a desired shape by detecting the etching amount quite accurately as to the film of a various thickness in a wide range to be processed. Therefore, applicants submit that independent claims 1 and 4 recite features not disclosed by Helmann et al in the sense of 35 USC 102 and all claims should be considered allowable thereover.

Turning to Coronel et al, applicants note that such patent, i.e., USP 5,658,418 (reference 2), is cited at page 4 of the specification, and the deficiencies thereof are described in the specification. Coronel et al is similar to the present invention in a

point that the intensity, particularly, maximum or minimum value of an interference light of different waveforms is detected. Coronel et al detects a remaining thickness of a film in a manner that a time point at which the change of the intensity of the interference light of each of wavelengths becomes maximum or minimum is calculated thereby to detect the change of a film thickness from the product of the wavelength and a coefficient and also detect a remaining film thickness from a particular calculation value. Coronel et al employs plural waveforms so as to perform accurate detection by referring the data of another waveform even in the case where there is erroneous detection as to one of the waveforms. In contrast, according to the present invention, the plural waveforms are employed due to such a unique technical concept that the etching amount is detected by utilizing the change of the intensities of the interference light of plural waveforms in a manner that time points where the intensities of the interference light of plural waveforms becomes respectively maximum and minimum within a particular time period are detected. Thus, applicants submit that Coronel et al fails to disclose the feature of "a determining device which determines an etching quantity of the wafer, which varies as long as the etching process proceeds, based upon a particular change arising in the interference light of plural pairs of wavelengths, the plural pairs of the wavelengths corresponding to the etching quantities, respectively, and the particular change being detected by using detected results obtained from the detector", as recited in claims 1 and 4, and all claims patentably distinguish thereover and should be allowable.

With respect to the dependent claims, such claims recite additional features when considered with the parent claims and further patentably distinguish over the cited art.

In view of the above amendments and remarks, applicants submit that all claims present in this application should now be in condition for allowance and issuance of an action of favorable nature is courteously solicited.

To the extent necessary, applicants petition for an extension of time under 37 CFR 1.136. Please charge any shortage in the fees due in connection with the filing of this paper, including extension of time fees, to the deposit account of Antonelli, Terry, Stout & Kraus, LLP, Deposit Account No. 01-2135 (Case: 500.43580X00), and please credit any excess fees to such deposit account.

Respectfully submitted,

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